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BAND PION

FOR NEUTRINO FACTORIES

B.J. King, N.V. Mokhov,

PRODUCTION

AND MUON COLLIDERS

N. Simos, R.V. Weggel

TARGET

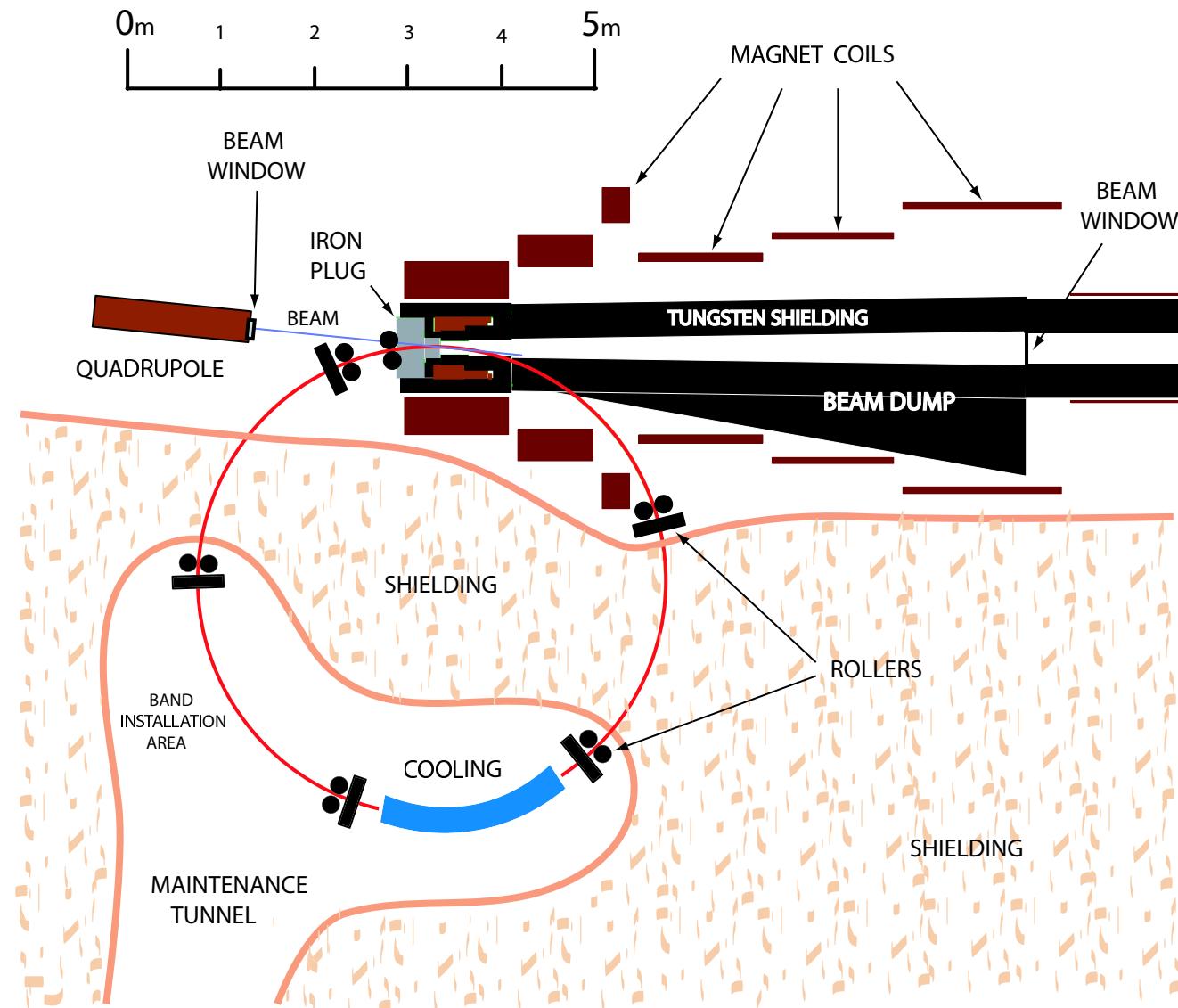
TPAH136

MOTIVATION

To develop a conceptual
design for a relatively
conventional (solid) pion
production target for muon
colliders & neutrino factories.

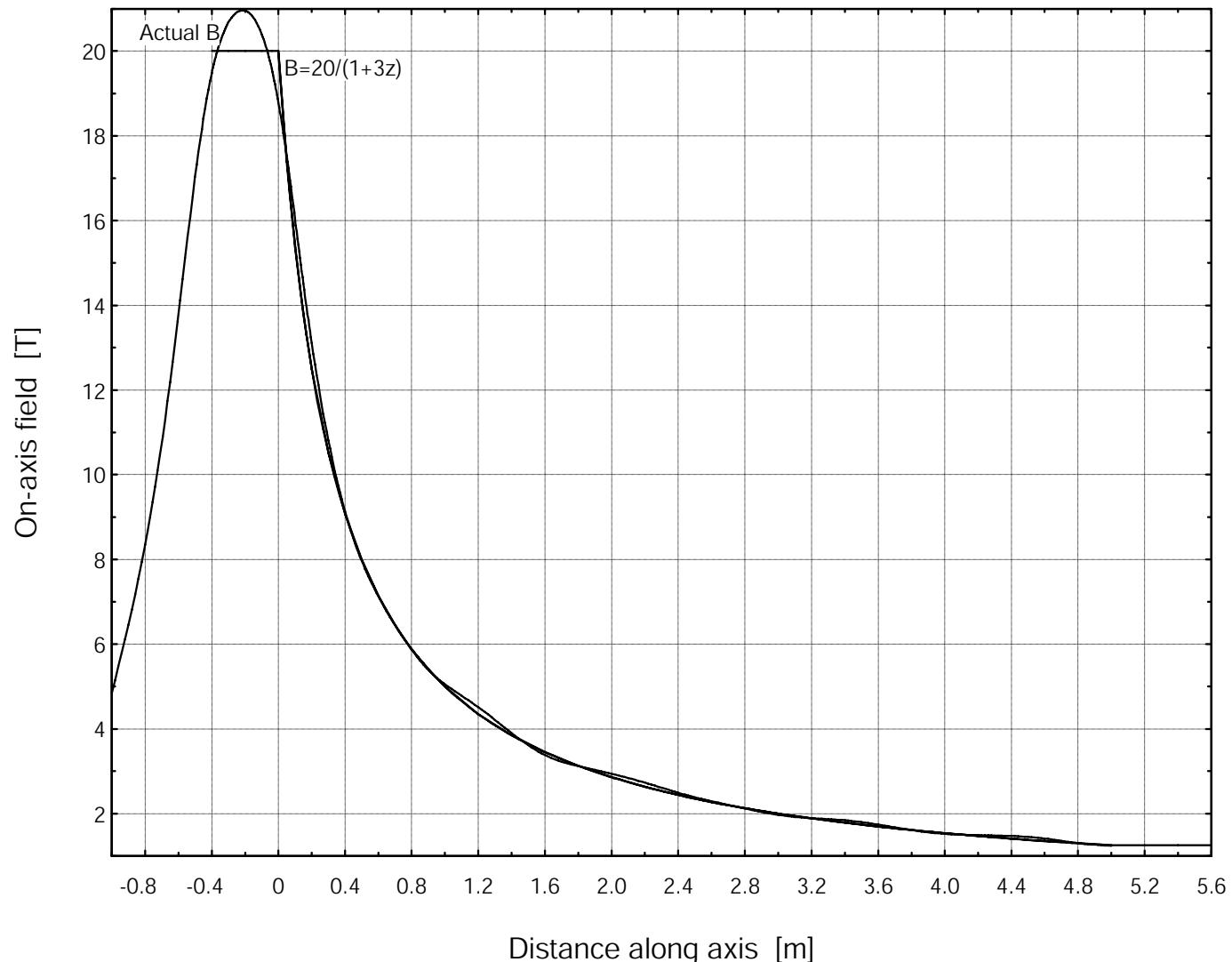
LAYOUT

Plan View of Target Layout

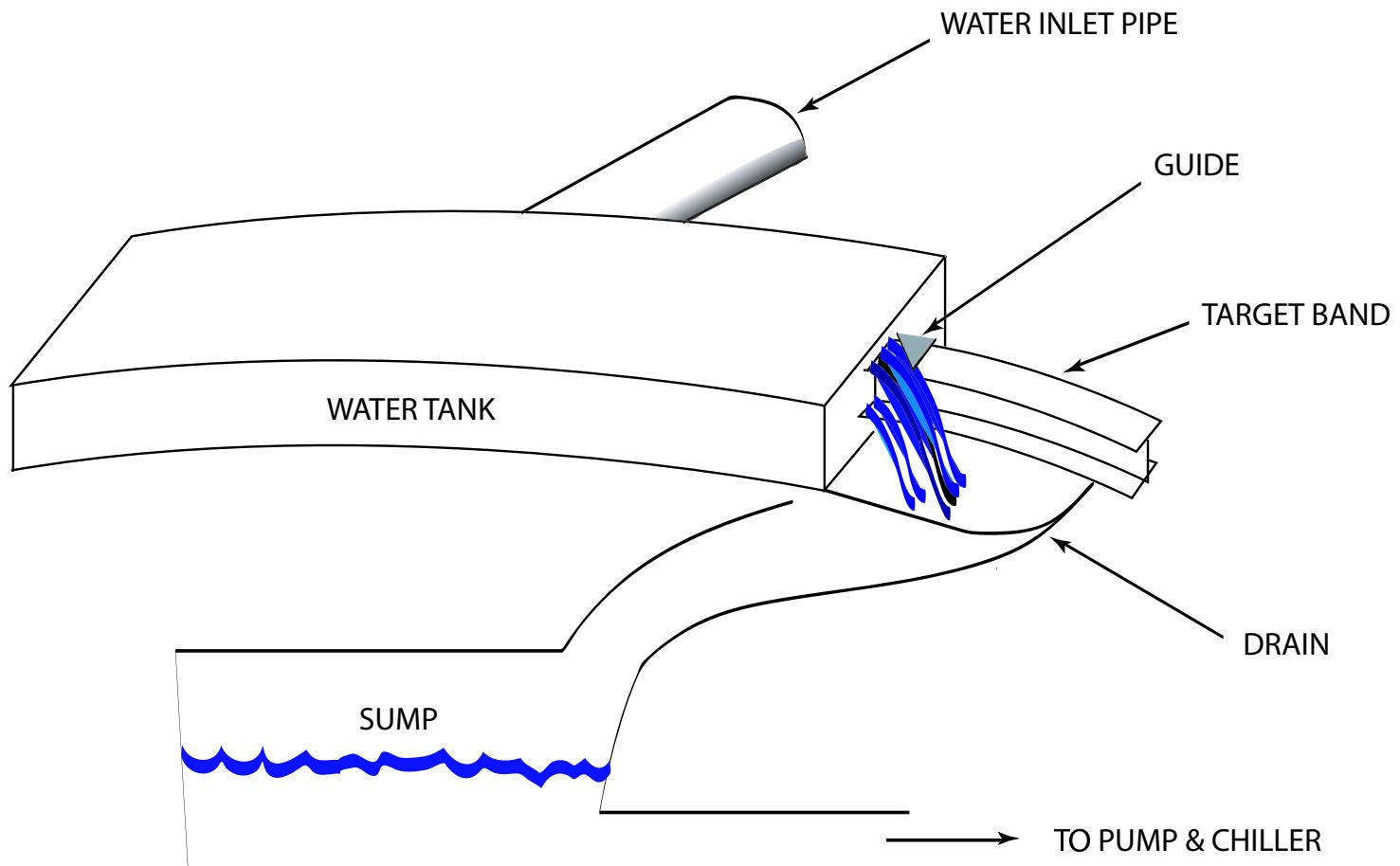


CAPTURE MAGNET FIELD PROFILE

Field Profile of Magnet for Bandsaw Target



Water Cooling Tank



Cooling over a large surface area => modest cooling parameters

THE BAND

BAND MATERIAL OPTIONS

	<u>Inconel 718</u>	<u>Ti-Alloy Grade 5</u>	<u>Nickel</u>
composition by wt.	54%Ni,19%Cr,17%Fe,5%Nb	90% Ti, 6% Al, 4% V	100% Ni
ave. atomic wt.		48	58.7
density [g/cm ³]	8.19	4.43	8.90
interaction length [cm]	16.6	~30	15.2
elect. conductivity [MS/m]	0.8	0.56	14
0.2% yield strength [10 ⁸ N/m]	7.4-11	9.7	0.59*
fatigue strength [10 ⁸ N/m]	6	7 @ 10 ⁷ cycles	-

Used in nuclear reactors,
aerospace, beam windows

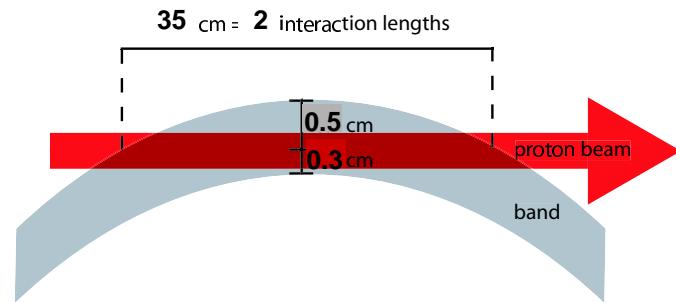
Common alloy, used
in beam windows at
CERN

Common target
choice, e.g
FNAL p-bar
target at 500-
600 J/g =>
*evades yield
strength limit

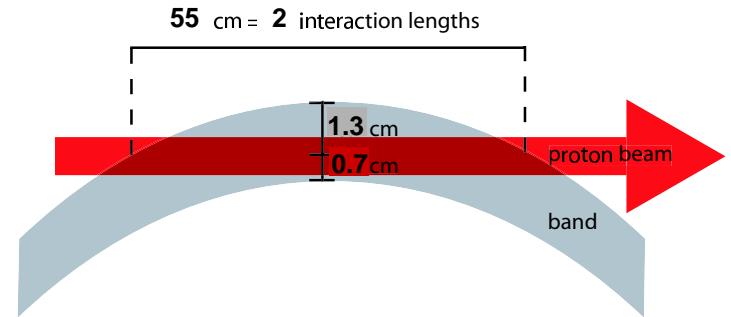
BAND & BEAM

Inconel & Nickel

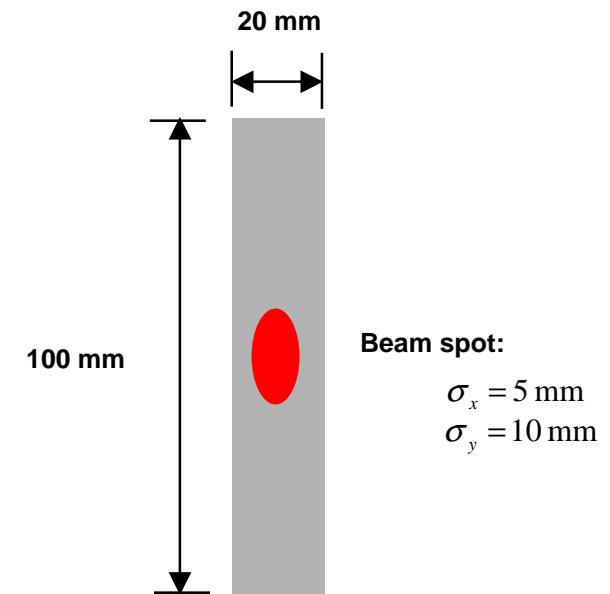
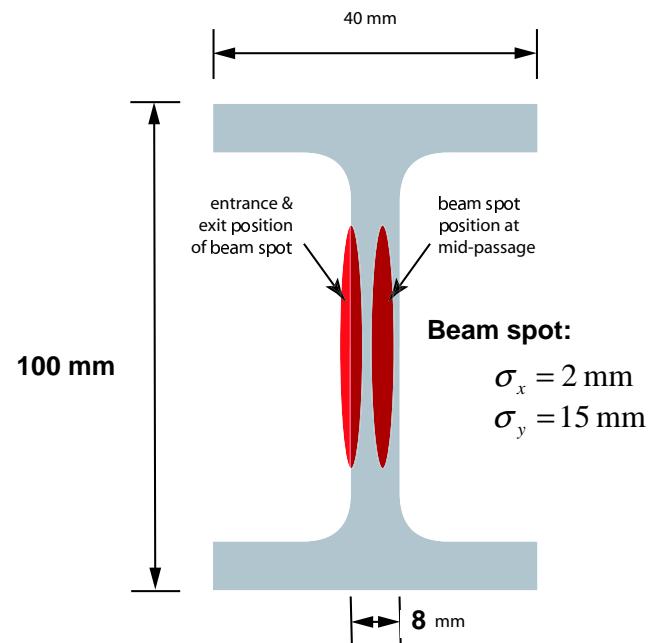
plan view:



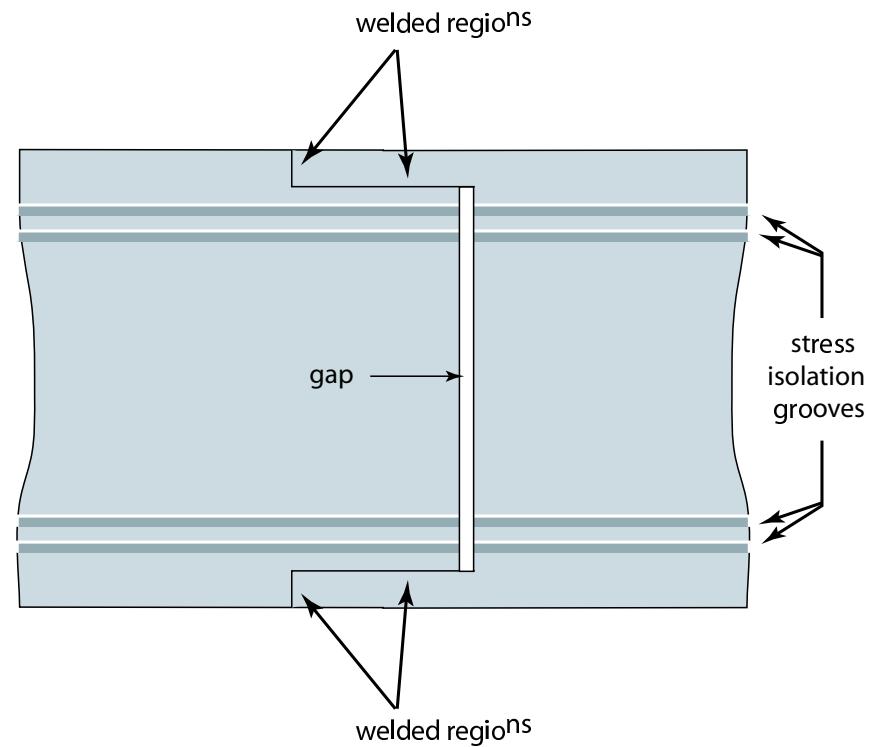
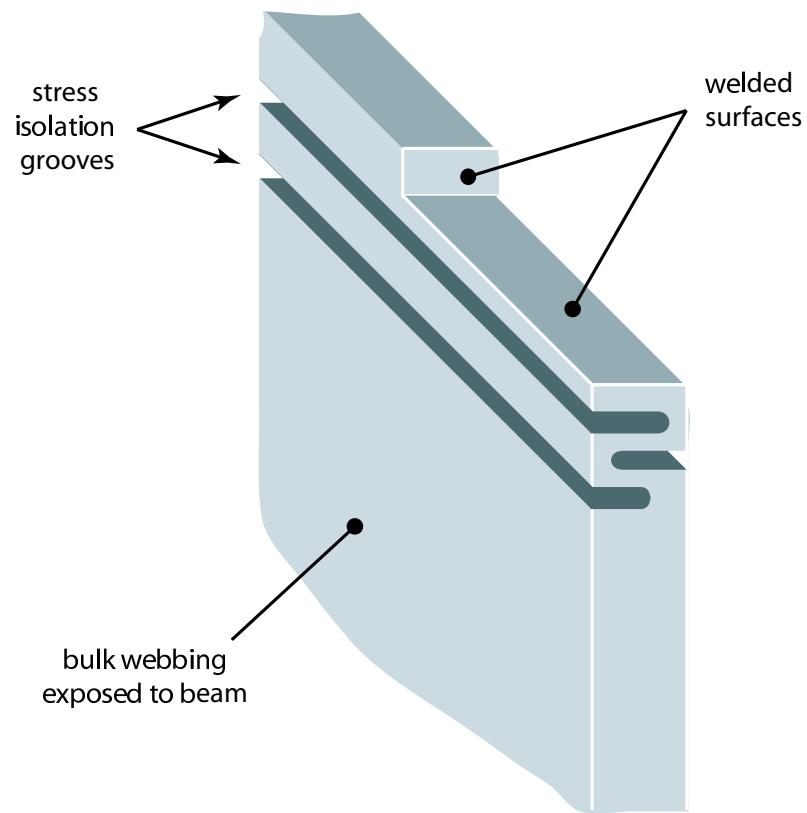
Ti-Alloy



looking down the beam:



STRESS PROTECTION FOR WELDS



PION YIELD

Detailed MARS track-by-track Monte Carlo Calculations for $E_{\text{proton}} = 6, 24 \text{ GeV}$

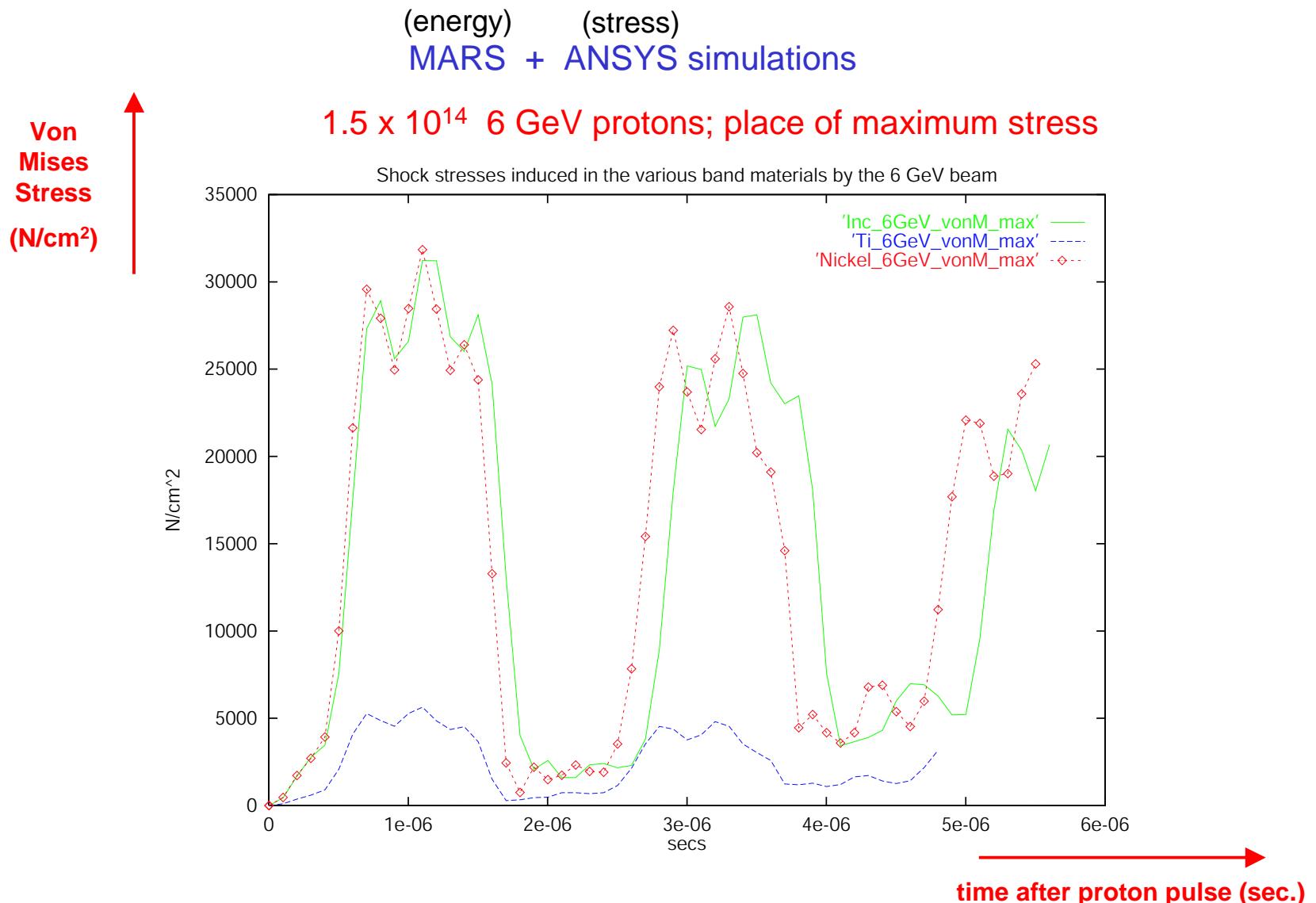
- Y2sum = yield per proton of +ve & -ve mesons that result in muons with $32 < E_{\text{kin}} < 232 \text{ MeV}$
~ expected to make it through the entire phase rotation channel
- ppp_3.2 = protons-per-pulse for 3.2×10^{13} captured muons (summing both signs)
($\times \frac{1}{4}$ survival for cooling and acceleration => 4×10^{12} muons/bunch in collider ring)
- Ep3.2 = corresponding proton energy/bunch

Eproton (GeV)	Target	Y2sum	(looks OK)	
			ppp_3.2 (10^{13})	Ep3.2 (kJ)
6	inconel	0.207	15.5	149
	Ti-alloy	0.163	19.6	188
	nickel	0.206	15.5	149
24	inconel	0.576	5.56	214
	Ti-alloy	0.472	6.78	260
	nickel	0.594	5.39	207

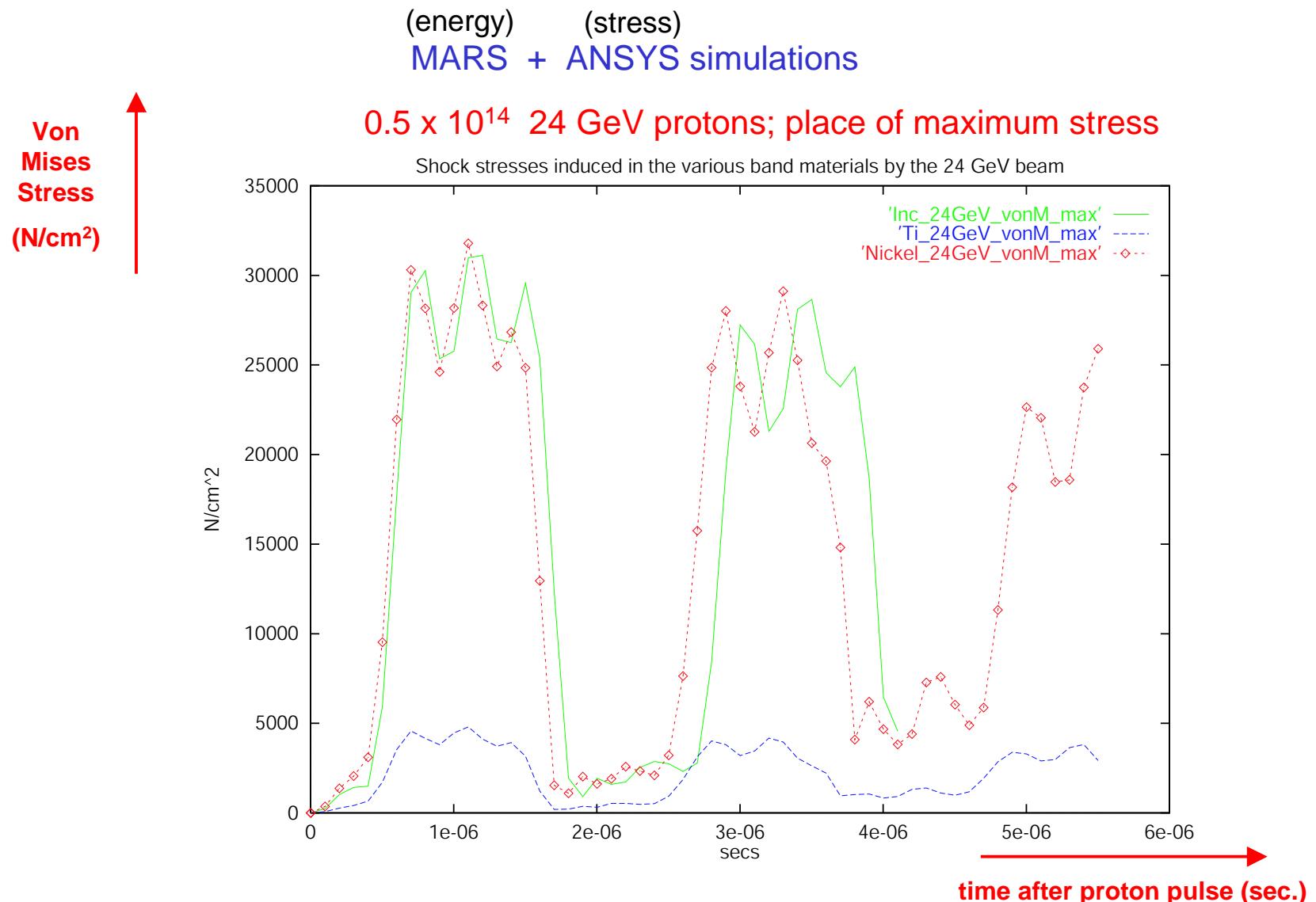
Inconel and nickel are similar, Ti-alloy requires ~20% more protons.

STRESS
STUDIES

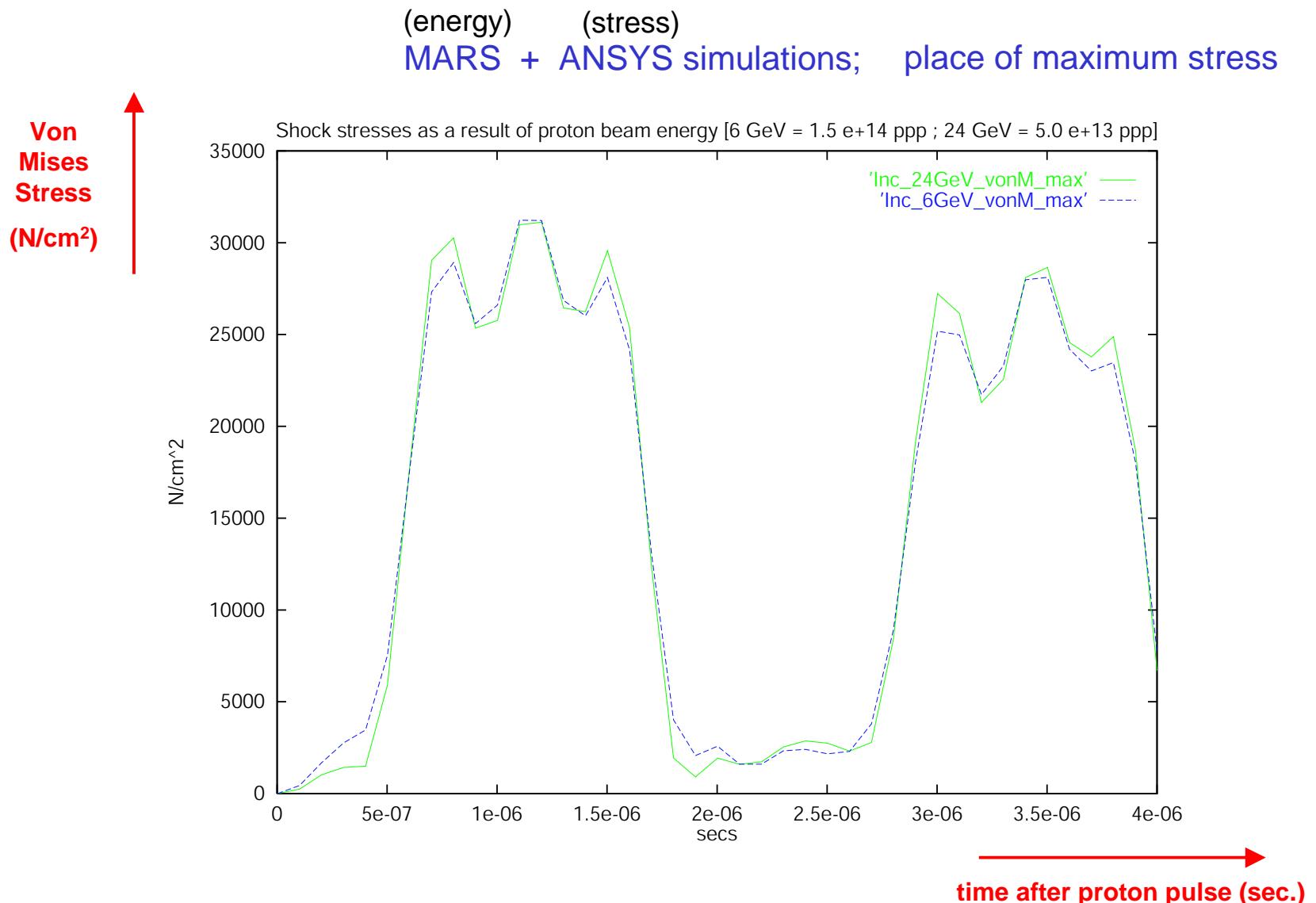
Von Mises Stress Development for 6 GeV protons



Von Mises Stress Development for 24 GeV protons

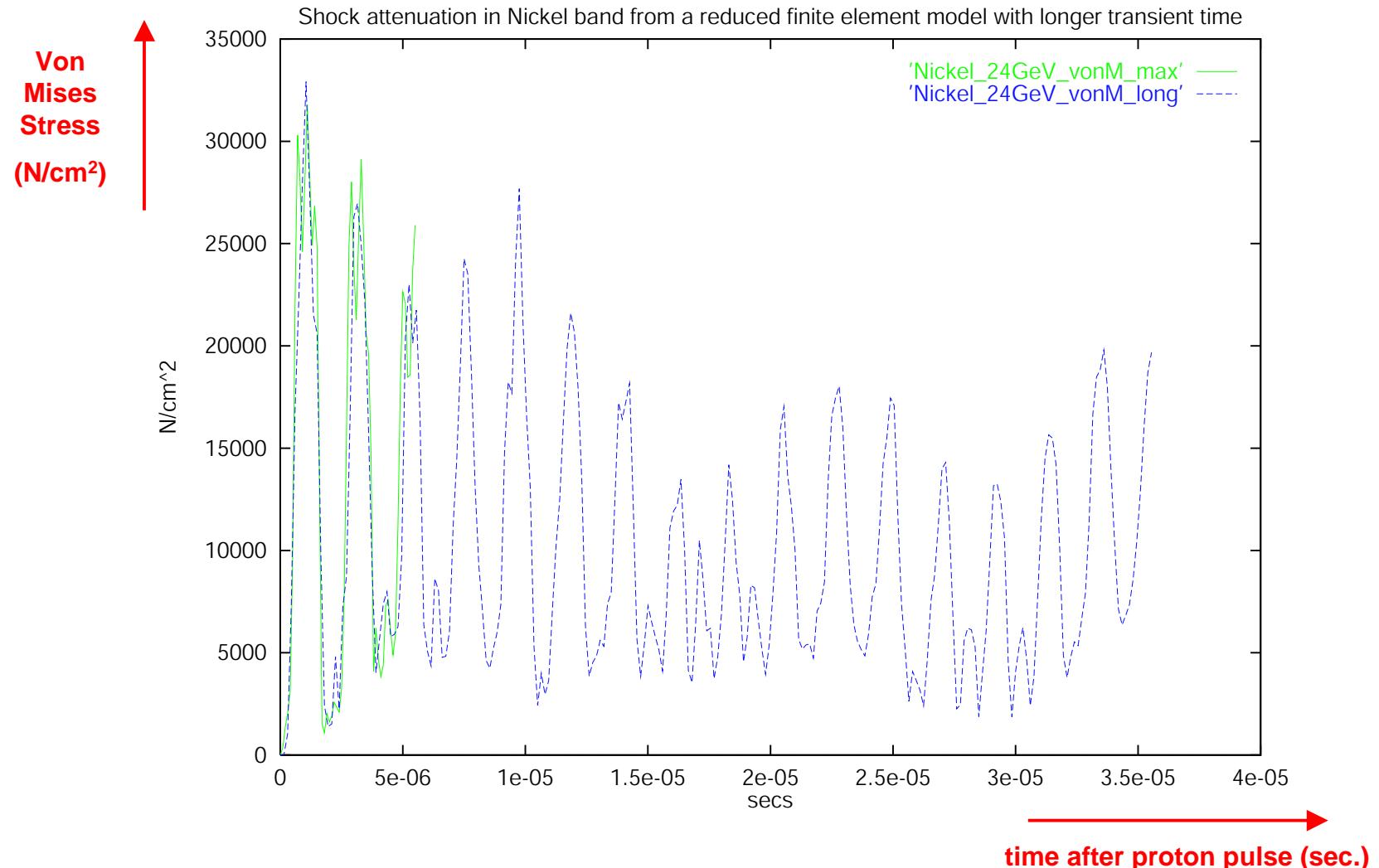


Stress Comparison: 6 vs. 24 GeV protons



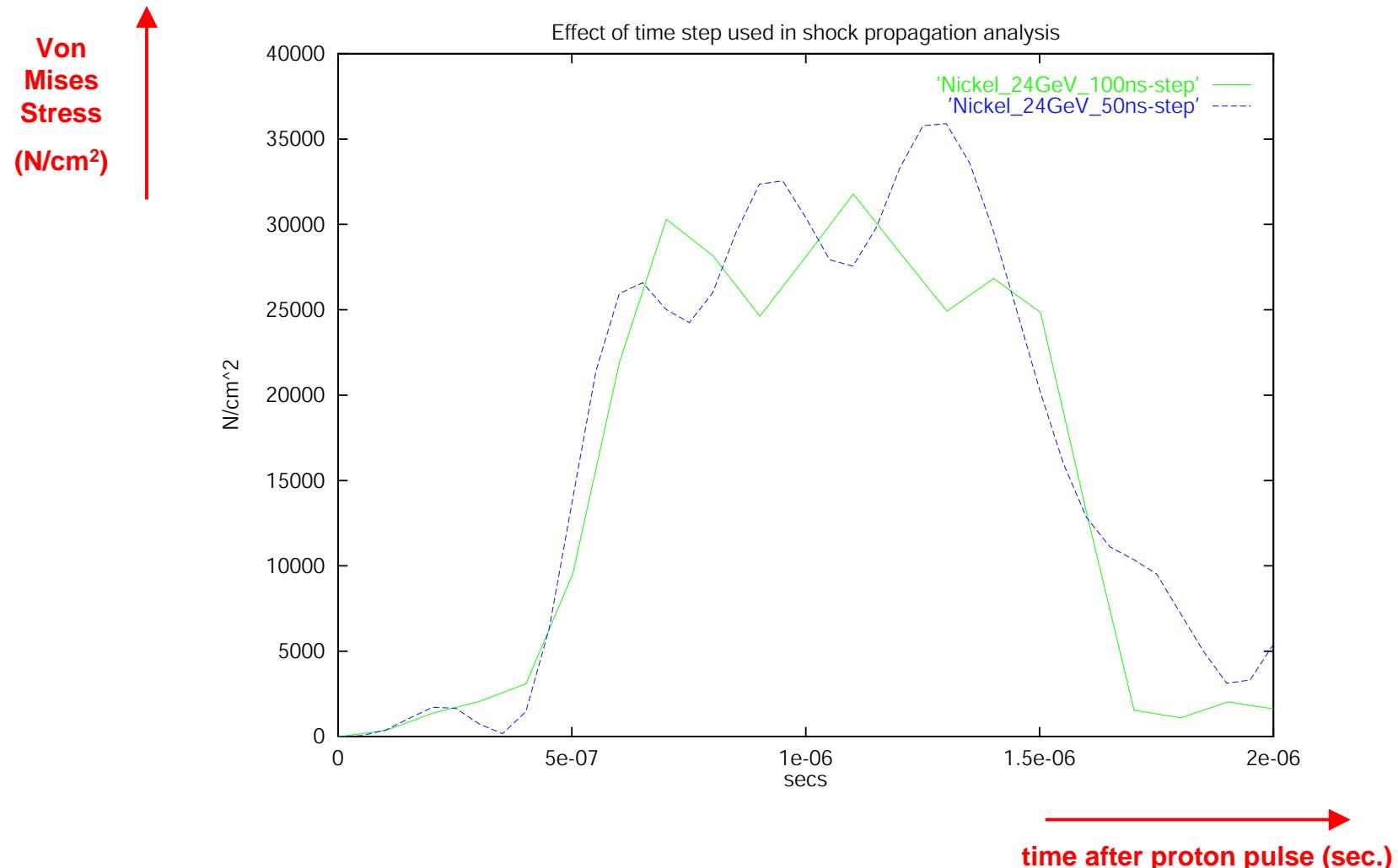
Stress Damping

(energy) (stress)
MARS + ANSYS simulations; place of maximum stress



Stress Model Check: Sensitivity to Time Step

(energy) (stress)
MARS + ANSYS simulations; place of maximum stress



Target Stresses @

E_{proton} = 6, 24 GeV

Maximum von Mises stresses, in both time and position, calculated from detailed MARS predictions of energy depositions plus detailed 3-D ANSYS calculations

- **U_max** = max. energy density deposited in the band for a proton bunch that makes 3.2×10^{13} captured mesons (see previous slide on yield)
- **VM_max_3.2** = max. Von Mises stresses for a proton bunch that makes 3.2×10^{13} captured mesons
- **FS** = fatigue strength (see previous slide on material properties)

E _{proton} (GeV)	Target	U _{max} (J/g)	VM _{max_3.2} (10^8 N/m ²)	FS (10^8 N/m ²)	% of FS
6	inconel	32.0	3.3	6.0	55% ~OK if confirmed
	Ti-alloy	25.6	0.72	7.0	10% nice!
	nickel	32.5	3.3	N.A.	N.A.
24	inconel	31.7	3.6	6.0	60% ~OK if confirmed
	Ti-alloy	21.3	0.68	7.0	10% nice!
	nickel	37.4	3.4	N.A.	N.A.

SUMMARY

Although it is unlikely to yet be an optimal design in all respects, this target design can already be considered to provide an existence proof that targetry for neutrino factories & muon colliders is feasible.